DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – PART I			
Name of the programme and specialization	M.Tech. / Power Systems		
Course Title	High Voltage DC Transmission		
Course Code	EE662	No. of Credits	3
Course Code of Pre-requisite subject(s)			
Session	July 2023	Section (if, applicable)	---
Name of Faculty	M. VENKATA KIRTHIGA	Department	EEE
Email	hvdctrans@gmail.com	Telephone No.	0431-250 3263
Name of Course Coordinator(s) (if, applicable)	NA		
E-mail		Telephone No.	
Course Type	Programme Elective		

Syllabus (approved in BoS)

Introduction to HVDC transmission, Comparison between HVAC and HVDC systems - economic, technical and reliability, limitations, Types of HVDC links - monopolar, bipolar and homopolar links, Components of HVDC transmission system

Analysis of HVDC Converters, Rectifier and Inverter operation of Graetz circuit without and with overlap. Output voltage waveforms and DC voltage in both rectifier and inverter operation, Equivalent circuit of HVDC link.

Basic means of HVDC system control, desired features, power reversal, Basic controllers – constant ignition angle, constant current and constant extinction/ advance angle control, power control, high level controllers. Converter maloperations - misfire, arc through, commutationfailure

Harmonics in HVDC system - Characteristic and uncharacteristic harmonics - troubles due to harmonics – harmonic filters - active and passive filters - Reactive power control of converters, Protection issues in HVDC, over voltage and over current protection, voltage and current oscillations, DC reactor design, DC Circuit breakers

Recent trends in HVDC transmission-CCC based HVDC system, VSC based HVDC system,– Multiterminal HVDC systems and HVDC system applications in wind power generation, Interaction between AC and DC systems

Text Books / Reference Books:

1. Kimbark, E.W., 'Direct Current Transmission-vol.1', Wiley Inter science, New York, 1971.
2. Padiyar, K.R., 'HVDC transmission systems', New Age Publishers, 2017.
3. Kamakshaiah, S and Kamaraju, V, 'HVDC Transmission', II Edition, Tata McGraw Hill Education (India), New Delhi 2017.
4. Arrilaga, J., 'High Voltage Direct Current Transmission', 2nd Edition, Institution of Engineering and Technology, London, 1998.
5. Vijay K. Sood, 'HVDC and FACTS Controllers', Kluwer Academic Publishers, New York, 2013.

COURSE OBJECTIVES

To facilitate the students, understand the basic concepts and recent trends in HVDC transmission system and its applications.

COURSE OUTCOMES (CO)

Course Outcomes

Upon completion of the course the students would be able to

1. Appraise the need of HVDC technology for bulk power transmissionand choose appropriate type of HVDC link and converter
2. Analyze the operation of Graetz circuit as rectifier and inverterwithout and with overlap.
3. Evaluate the operation and efficacy of different controllers and analyze the different faults in HVDC systems
4. Discriminate and evaluate the issues related with harmonics,reactive power control and protection of HVDC system
5. Recognize and appraise the recent trends in HVDC transmissionsystems.

Course articulation matrix (CO-PO mapping)

CO \ PO	PO1	PO2	PO3
CO1	2	2	3
CO2	2	2	3
CO3	3	3	3
CO4	3	3	3
CO5	3	3	3

COURSE PLAN – PART II

COURSE OVERVIEW

In view of catering the needs of increased demand owing to industrialization and various other developments, power engineers are keen to develop various control measures. HVDC and FACTS play major role in bridging the gap between the demand and generation by reducing the transmission and distribution losses. HVDC transmission systems are gaining importance in the past three decades and given more emphasis in the recent years.

Thanks to the effective controllability and advanced controllers, HVDC Transmission systems are becoming more robust and stable day by day. It becomes inevitable for a power engineer to know the nuances of the HVDC technology and it's the need of the hour to learn about the HVDC technology at post graduation level.

COURSE TEACHING AND LEARNING ACTIVITIES

S. No.	Week/Contact Hours	Topic	Mode of Delivery
1.	IV week of August **25.08.23 - 1 hr**	Introduction to the course on HVDC Transmission, mode of course delivery, syllabus content and need for the study of the course	**Chalk and Talk / Power Point Presentation**
2.	V week of August **28.08.23 to 01.09.23 3 hrs**	Comparison between HVAC and HVDC systems -economic, technical and reliability, limitations	
3.	I week of September **04.09.23 to 08.09.23 3 hrs**	Types of HVDC links - monopolar, bipolar and homopolar links, Components of HVDC transmissionsystems	
4.	II week of September **11.09.23 to 15.09.23 3 hrs**	Analysis of HVDC Converters, Rectifier and Inverter operation of Graetz circuit without and with overlap	
5.	III week of September **18.09.23 to 22.09.23 2 hrs**	Output voltage waveforms and DCvoltage in rectifier and Output voltage waveforms in inverter operation.	
6.	I week of October **03.10.23 to 06.10.23 1 hr**	**Assessment I**	

7.	I week of October **03.10.23 to 06.10.23** **1 hr**	Equivalent circuit of HVDC link.	
8.	IV and V weeks of October **09.10.23 to 13.10.23** **14.10.23 to 18.10.23** **6 hrs**	Relevant equations for equivalent circuit model. Basic means of HVDC system control, desired features, power reversal Converter maloperations - misfire, arc through, commutation failure Harmonics in HVDC systems-	**Chalk and Talk / Power Point Presentation**
9.	IV and V weeks of October **27.10.23 to 03.11.23** **4 hrs**		
10.	I week of November **06.11.23 to 10.11.23** **1 hr**	**Assessment II**	
11.	I week of November **06.11.23 to 10.11.23** **2 hrs**	Characteristic and uncharacteristic harmonics - troubles due to harmonics Impact of harmonics and introduction to harmonic filters Harmonic filters - active and passive filters - Reactive power control ofconverters. Protection issues in HVDC, over voltage and over current protection, voltage andcurrent oscillations, DC reactor design, DC Circuit breakers	**Chalk and Talk / Power Point Presentation**
12.	II week of November **13.11.23 to 17.11.23** **2 hrs**		
13.	III week of November **20.11.23 to 24.11.23** **3 hrs**		
14.	IV of November **28.11.23 to 01.12.23** **2 hrs**	Recent trends in HVDC Transmission, Multi-terminal and Multi-infeed systems	
15.	I week of December **04.12.23 to 08.12.23**	**Assessment III**	**Group Activity – Students have to demonstrate the simulation work carried out and give a presentation**
16.	II week of December **11.12.23 to 15.12.23**	**Assessment III**	**Group Activity – Students have to demonstrate the simulation work carried out and give a presentation**

17.	I week of December **04.12.23 to 08.12.23** **1 hr**	**Compensation Test**	**Portions of Assessment I and II – 20% weightage**
18.	III week of December **18.12.23 to 22.12.23**	**Final Assessment**	**End semester exam - Descriptive type**

COURSE ASSESSMENT METHODS

S.No	Mode of Assessment	Week/Date	Duration	% Weightage
1	**Assessment I** Objective type	I week of October **03.10.23 to 06.10.23**	1 hr	20
2	**Assessment II** Objective type	I week of November **06.11.23 to 10.11.23**	1 hr	20
3	**Assessment III** Group Activity Demonstration by students in groups	I and II weeks of December **04.12.23 to 15.12.23**	Appropriate Timing based on the number of students	20
CPA	Compensation Assessment	Portions of Assessments I and II	1 hr	20
4	**Assessment V** Final Assessment Descriptive Type	III week of December **18.12.23 to 22.12.23**	2.5 hrs	40

COURSE EXIT SURVEY

1. Students' feedback through class committee meetings
2. Feedback questionnaire from students – twice during the semester
3. Feedback from students on Course Outcomes at the end of the semester

COURSE POLICY

MODE OF CORRESPONDENCE

1. All the students are advised to check their NITT WEBMAIL regularly. All the correspondence (schedule of classes/ schedule of assessment/ course material/ any other information regarding this course) will be done through their webmail only.

2. Queries (if required) to the course teacher shall only be emailed to hvdctrans@gmail.com

COMPENSATION ASSESSMENT POLICY

- CPA will be offered only for the students who could not appear for Assessments 1 or/and 2.

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- **At least 75% attendance in each course is mandatory.**
- **A maximum of 10% shall be allowed under On Duty (OD) category.**
- Students with **less than 65% of attendance** shall be prevented from writing the final assessment and **shall be awarded 'V' grade.**

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to theAcademic office.

The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION

The faculty is available for consultation at times as per the intimation given by the faculty. Queries may also be emailed to the Course Coordinator directly at hvdctrans@gmail.com

FOR APPROVAL

Course Faculty	CC-Chairperson	HoD/EEE
Dr. M. VENKATAKIRTHIGA	Dr. KARTHIK THIRUMALA	Dr. M P. SELVAN
	28/8/23	30/08/23